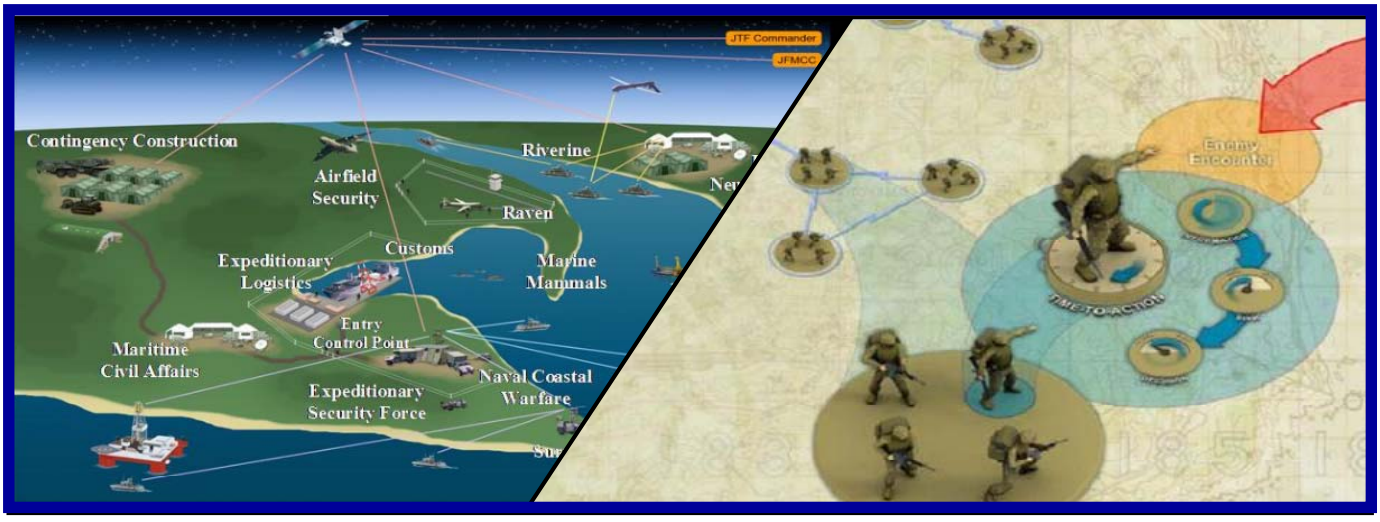
Revolutionary Research . . . Relevant Results

Science and Technology in Support of Naval Distributed Operations

Workshop #2 – Final Report
20-21 March 2007



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Office of Naval Research
Expeditionary Maneuver Warfare and Combating Terrorism S&T Division
875 North Randolph Street, Suite 1425
Arlington, Virginia 22203-1995

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Executive Summary

The Office of Naval Research (ONR) organized and hosted a *Science and Technology (S&T) in Support of Naval Distributed Operations Workshop* on 20 and 21 March 2007. The *Expeditionary Maneuver Warfare and Combating Terrorism S&T Department* (ONR 30) conducted this workshop, partly in response to the 2005 *Naval Research Advisory Committee (NRAC) Distributed Operations Summer Study*, and partly to inform the Combat Development and Concept Definition processes. This report communicates the results of the ONR 30 workshop and takes the S&T aspects of the NRAC report to the next level of detail.

The workshop had three primary purposes:

1. Identify key Distributed Operations (DO) capability gaps.
2. Inform and energize the collaboration of key Naval stakeholders with respect to DO-related S&T initiatives.
3. Inform the Marine Corps and Navy Expeditionary Combat Enterprise (NECE) Science and Technology Objective (STO) development/review process.

Eighty-six participants representing both the Marine Corps and the NECE made this workshop a truly *Naval* event. Additionally, strong representation from the Combat Development, Material Development, and Technology Development communities helped mitigate conflicting technology time horizons and synchronized technology expectations across the Naval Enterprise.

The following (unprioritized) list is a consolidation and synthesis of the key DO-related capability gaps identified by the workshop participants:

1. Communicate and share information with distributed small-units located beyond line-of-sight, on the move, and within complex terrain in order to assure real-time access to required levels of functional support.
2. Maintain an adaptable, self-forming (aggregating/disaggregating), and self-regulating (bandwidth control) C^2 system in order to maintain an autonomous multi-echelon Common Operational Picture (COP) and facilitate synchronization of effort across the area of operations.
3. Communicate (voice & data) and collaborate (information management and data sharing) with all relevant organizations within a distributed force's areas of interest in order to facilitate unity of purpose and optimize the use of critical resources.
4. Achieve and maintain real-time automatic situational awareness of relevant non-blue activities at all echelons in order to mitigate the increased operational risk to small-units engaged in Distributed Operations.
5. Conduct real-time automatic detection, tagging, tracking, and locating of known and potential threats in order to eliminate the irregular threat's freedom of movement.
6. Collect relevant social data and fuse it to facilitate assessments and predictions for operational benefit in order to dominate the human domain of warfare.

7. Automatically sense, package, and rapidly deliver tailored logistics packages from the Seabase to distant small-units operating on a distributed battlefield in order to enable Distributed Operations.
8. Reduce sustainment demand of distributed small-units in order to decrease stress to the Seabased logistics system
9. Conduct advanced casualty stabilization & long-range evacuation at the small-unit level in order to mitigate the increased operational risk to small-units engaged in Distributed Operations
10. Rapidly enhance Warfighter cognitive processes and experiential baselines in order to prepare leaders at echelons for Distributed Operations
11. Enhance Warfighter physiological/psychological performance in order to mitigate the increased risks of Distributed Operations
12. Rapidly acquire the operational culture and language skills in order to dominate the virtual and human domains of warfare
13. Conduct dynamic mission preparation, training, and rehearsal while deployed aboard ship or in theater in order to enhance operational performance and minimize unintended consequences
14. Conduct selected core Information Operations activities at the small-unit level in order to dominate the influence battle
15. Protect critical infrastructure in order to maintain essential services and bolster the legitimacy of the supported civil authority

The Marine Corps Combat Development Command (MCCDC) will complete its formal DO concept and capability development process during June 2007. This ONR 30 report will help inform this formal process and will facilitate the identification of long-term capability gaps requiring the focused expenditure of Technology Developer resources. ONR 30 also expects this report to influence the ongoing revision of the Marine Corps S&T Strategic Plan and the development of the NECE S&T Strategic Plan. Each of these activities will reach their conclusions during the upcoming Summer. Once completed, the outputs of these activities will inform the ONR S&T investment strategy for DO and will energize its continuing advocacy of the S&T needs of the future Naval Warfighter.

George W. Solhan
Senior Executive Service
Deputy Chief of Naval Research, Expeditionary Maneuver Warfare & Combating Terrorism S&T, ONR Code 30

SCIENCE AND TECHNOLOGY IN SUPPORT OF NAVAL DISTRIBUTED OPERATIONS

WORKSHOP #2 – FINAL REPORT

"Highly distributed global operations over the past several years…make manifest the importance of small teams conducting missions uniquely tailored to local conditions."

– Quadrennial Defense Review 2006

"Distributed Operations describe an operational approach that creates an advantage over an adversary through the deliberate use of separate, coordinated and interdependent actions. Distributed Operations are enabled by improved access to functional support, as well as by enhanced combat capabilities at tactical levels. Distributed Operations are essentially a form of maneuver warfare in all domains and dimensions."

– Major Combat Operations Joint Operating Concept 2006

Introduction and Background

The above extracts from strategic guidance highlight the fact that Distributed Operations (DO) is evolving into a key operational concept for future U.S. military operations. Furthermore, future Joint Forces Commanders will not limit DO methodologies to land component operations. In fact, the *Naval Operating Concept (2006)* declares that DO is a key *Naval* methodology and the *Navy Strategic Plan (2006)* identifies distributed networked operations as the "overarching global Navy concept." The Navy Expeditionary Combat Enterprise (NECE) has fully embraced the importance of DO and, just prior to the conduct of the workshop that is the subject of this report, the Marine Corps published a revised edition of its concept for DO.[1] This revision defines DO as follows:

"Distributed Operations is a technique applied to an appropriate situation wherein units are separated beyond the limits of mutual support. Distributed Operations are practiced by general purpose forces, operating with deliberate dispersion, where necessary and tactically prudent, and decentralized decision-making consistent with commander's intent to achieve advantages over an enemy in time and space. Distributed Operations relies on the ability and judgment of Marines at every level and is particularly enabled by excellence in leadership to ensure the ability to understand and influence an expanded operational environment"

[1] Marine Corps Operations in Complex and Distributed Environments, *Marine Corps Gazette* (March 2007), 12-14.

DO, as a concept, is alive and well. DO, however, is not a new concept. Warfighters have executed DO to varying degrees as the military situation warranted since the beginning of organized warfare. What is new about DO is the degree to which functional capability access will be pushed to the smallest tactical units, the physical depth and breadth of the envisioned small-unit DO battlespace, and the increased cognitive and training demands that will be paced on the most junior Navy and Marine Corps Warfighters.

Transforming the current DO vision into a reality will required a full DOTMLPF effort to overcome existing capability gaps and the associated risks to small-units engaged in DO.[2] Closing many of these gaps will require a focused Science and Technology (S&T) effort informed by the Combat Developer and supported by the Material Developer.[3] ONR's mission is "to foster, plan, facilitate, and transition scientific research in recognition of its paramount importance to enable future Naval power…" Toward this end, the *Naval S&T Strategic Plan (2007)* has established DO as one of its thirteen strategic S&T focus areas. (Figure 1).

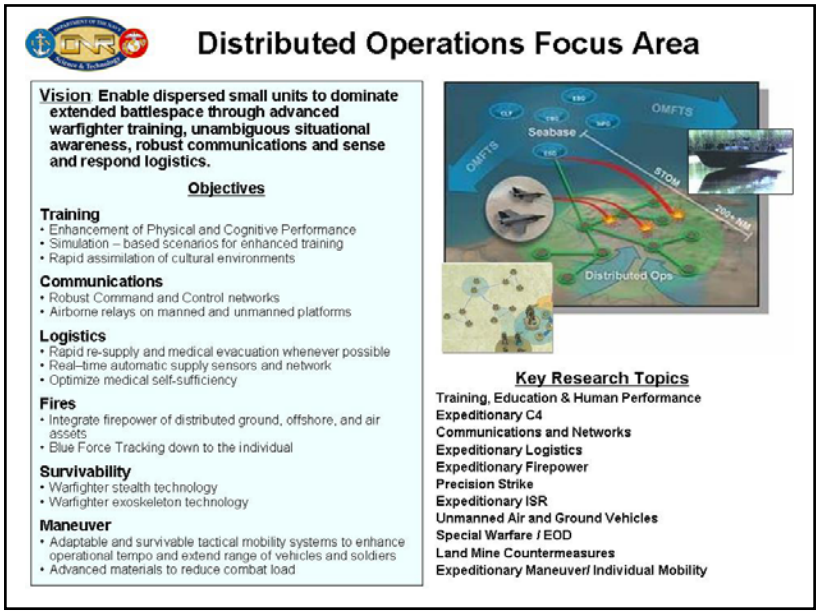

Figure 1: Naval S&T Strategic Plan Focus Area

The mission of ONR's Expeditionary Maneuver Warfare and Combating Terrorism Department (ONR 30) is "to lead the Department of the Navy's Science and Technology effort that develops future combat capabilities for Naval Expeditionary Maneuver Warfare and the Department's role in Combating Terrorism through the exploitation and subsequent application of Science and Technology in order to enhance the ability of the Navy-Marine Corps team..." Because

[2] DOTMLPF - doctrine, organization, training, materiel, leadership and education, personnel, & facilities

[3] Relevant Combat Developers include, but are not limited to, the Marine Corps Combat Development Command (MCCDC); the Office of the Chief of Naval Operations – Resources, Requirements and Assessments (OPNAV, N8); and Commander, U.S. Fleet Forces Command (CFFC). Relevant Technology Developers include, but are not limited to the Office of Naval Research (ONR) and the Defense Advanced Research Projects Agency (DARPA). Relevant Material Developers include, but are not limited to the Marine Corps Systems Command (MCSC) and the Navy Systems Commands (SysComs).

Distributed Operations are essentially a form of maneuver warfare in all domains and dimensions, the Chief of Naval Research (CNR) has designated ONR 30 as his executive agent for his DO focus area and for the coordination of the Defense S&T Enterprise's support to DO. [4] ONR 30 is fulfilling a portion of this responsibility with a series of workshops designed to identify a strategy for advancing and focusing the DoD S&T community's investment in Naval Distributed Operations technology development and for ensuring the transition of high-impact DO-related technologies to healthy Programs of Record. The first workshop in this series was conducted on 9 January 2007. The purpose of this workshop was threefold:

- Introduce participants to Naval DO and the "logic" for developing the DO S&T Investment Plan
- Inform the participants of the primary Marine Corps and Naval DO-related initiatives
- Preview Naval DO S&T Workshop (20-21 March) products, processes and expectations with the participants

Workshop Objectives

The ***S&T in Support of Naval DO Workshop #2*** was a continuation of ONR 30's strategy for fulfilling its DO-related responsibilities. It was conducted at the Wingate Hotel in Fredericksburg, VA from 20 to 21 March 2007. This workshop had three primary purposes:

1. **Identify key DO capability gaps.** In theory, the Technology Developers would determine the DO-related S&T gaps after the Combat Developers had identified and articulated the DO-related capability gaps and S&T objectives. (Figure 2) In practice, however, this process is often a collaborative endeavor by the Combat Developer, the Technology Developers, and even the Material Developers. (These three entities are the trinity of capability development and are

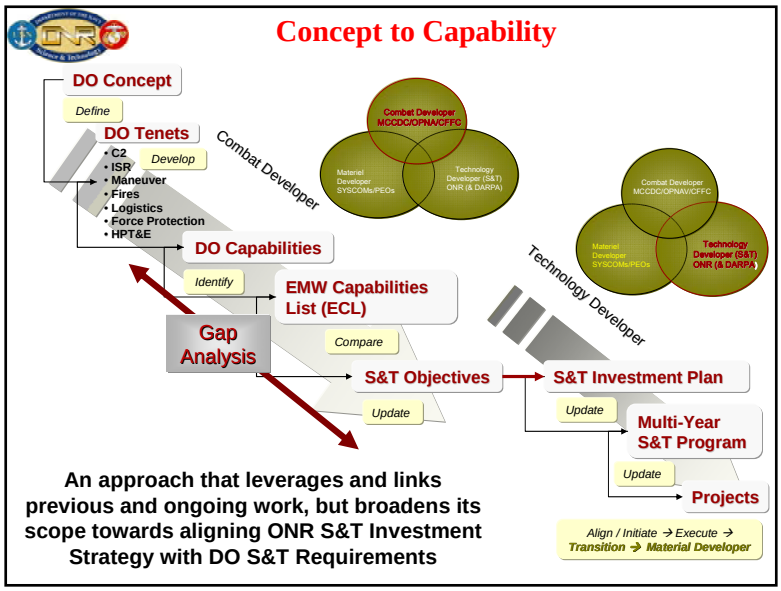

Figure 2: Concept to Capability

[4] Major Combat Operations Joint Operating Concept, version 2.0 (Dec 06), 15.

often referred to as the "three circles.") In anticipation of several imminent S&T planning and budgeting deadlines, ONR 30 initiated this workshop series to provide relevant input into its S&T investment planning activities. While the exact wording of the key capability gaps identified as a result of this workshop may not survive the formal Combat Developer process, they are expected to survive in spirit and intent.

2. **Inform and energize the "3-circle" construct with respect to DO-related S&T initiatives.** The "3-circle" construct consists of Naval Combat Developers, Technology Developers, and Material Developers. (Figure 3) Full engagement of the "3-circles" in the DO investment planning process is critical to ensure that the Technology Developers address the proper capability gaps with their limited resources and that the Material Developers are aware of how technology development efforts may effect and/or shape current and future Programs of Record.

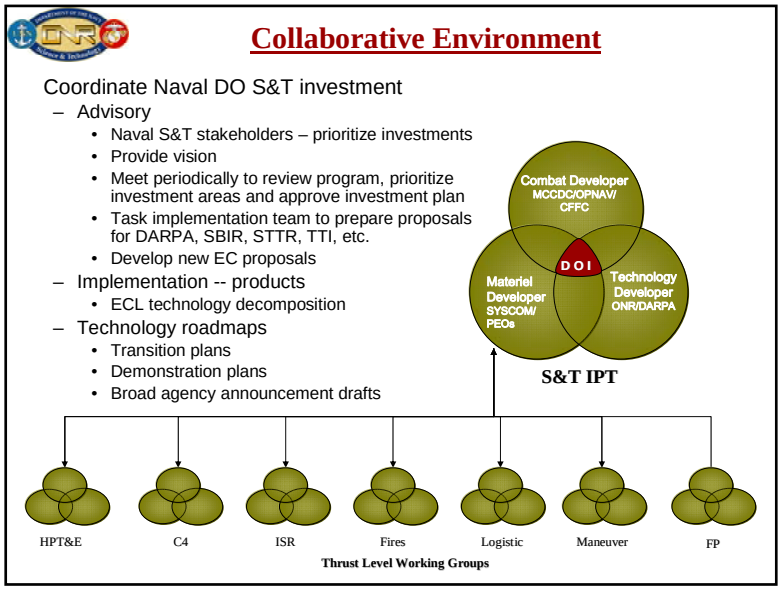

Figure 3: "3-circle" Construct

3. **Inform the Marine Corps and NECE S&T Objective (STO) development/review process.** The Deputy Commandant for Combat Development and Integration (DC, CD&I) updates the Marine Corps S&T Strategic Plan every two years. The 2005 version is currently in the review process. ONR 30 anticipates that the 2007 version will be published during August 2007. The NECE is currently preparing it first S&T Strategic Plan. ONR 30 anticipates that the NECE will publish its S&T plan during the summer of 2007. "3-circle" participation in this workshop will inform these ongoing development and review processes and will ensure that DO is fully addressed within these critical documents.

Workshop Participants and Organization

Eighty-six participants representing both the Marine Corps and the NECE made this workshop a truly a *Naval* event. Additionally, both services had appropriate "3-circle" representation. Current personnel challenges within the supporting establishments were also reflected by the fact that many organizations and stakeholders were represented by civilian contractors. Organizations represented during the workshop include the following:

- Marine Corps Combat Development Command (MCCDC)
- Naval Expeditionary Combatant Command (NECC)
- Defense Advanced Research Projects Agency (DARPA)
- Office of Naval Research (ONR)
- Marine Corps Systems Command (MCSC)
- Center for Naval Analyses (CNA)
- Naval Research Laboratory (NRL)
- Headquarters Marine Corps (HQMC)
- Marine Corps Warfighting Lab (MCWL)
- Peace Keeping and Stability Operations Institute (PKSOI)
- Security Cooperation and Education Training Center (SCETC)
- Space and Naval Warfare Systems Command (SPAWAR)

Workshop participants were divided into three working groups organized around the doctrinal phases of a joint military campaign.[5] (Figure 4 graphically portrays these phases and Appendix A contains a copy of the explanatory handout provided to the workshop participants.) The workshop organizers specifically avoided a working group structure based on the doctrinal

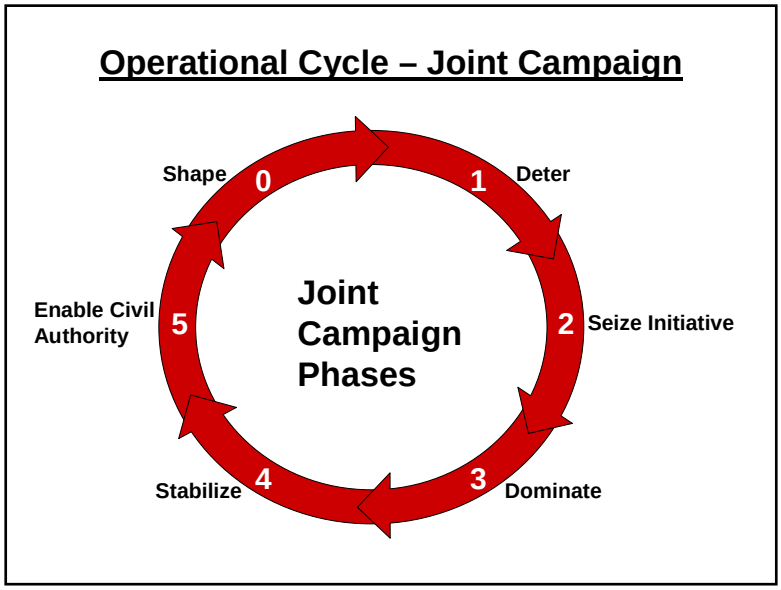

Figure 4: Phases of a Joint Campaign

[5] See pages IV-35 through IV-38 of Joint Publication 5-0: Joint Campaign Planning dtd 26 December 2006 for a detailed discussion of each phase of a Joint Campaign.

Warfighting functions in order to avoid "group think" and the duplication of past workshop results. The objective was for each working group to take a holistic view of the DO challenges and avoid fixating on one particular aspect of the challenge. To further support this objective, the workshop organizers made a concerted effort to evenly distribute Navy and USMC representatives, Warfighting function advocates/experts, and "3-circle" representatives between each of the three working groups. The senior uniformed member of the each working group was designated the group leader and was assisted by a senior facilitator (provided by ONR 30) and a note taker. Appendix B contains a participant roster with each participant's assignment to one of the following working groups:

Group A: This working group was formed and tasked to identify and articulate the DO-related challenges and key capability gaps confronting U.S. forces during ***Phase 0 (Shape)*** and ***Phase 1 (Deter)*** of a Joint Campaign. Operations and activities in these two phases are normally outlined in Security Cooperation Plans. They are designed to assure success by shaping perceptions and influencing the behavior of both allies and potential adversaries, developing allied and friendly military capabilities for self-defense and coalition operations, improving information exchange and intelligence sharing, and providing US forces with peacetime and contingency access.

Group B: This working group was formed and tasked to identify and articulate the DO-related challenges and key capability gaps confronting U.S. forces during ***Phase 2 (Seize the Initiative)*** and ***Phase 3 (Dominate)*** of a Joint Campaign. Operations and activities in these two phases are designed to seize the initiative in combat through the application of appropriate joint force capabilities and then break the enemy's will for organized resistance. These phases address the more traditional and kinetic aspects of warfare.

Group C: This working group was formed and tasked to identify and articulate the DO-related challenges and key capability gaps confronting U.S. forces during ***Phase 4 (Stabilize)*** and ***Phase 5 (Enable Civil Authority)*** of a Joint Campaign. Operations and activities in these two phases are designed to perform limited local governance, ensure that the threat (military and/or political) is reduced to a manageable level that can be controlled by the potential civil authority, and ultimately to enable the viability of the civil authority and its provision of essential services to the largest number of people in the region.

Workshop Dynamics

The 2-day workshop was divided into three major activity blocks: Introduction, Background and Concept of Operations (CONOPS) Review; Working Group Sessions; and Brief-outs.

Introduction, Background and CONOPS Review. Colonel Kevin Dodge, USMC (Deputy Department Head – ONR 30) welcomed the participants to the workshop on the morning of Day 1 and delivered the introductory brief found in section C1 of Appendix C. Col. Dodge's brief emphasized the following points:

- The Naval character of the workshop
- The opportunity for "3-circle" collaboration during the workshop

- The opportunity to impact the Marine Corps S&T Strategic Plan review and NECE Strategic Plan development processes
- The conflicting time horizons of the "3-circles" (see Figure 5)
- The need to get the best technologies to the Naval Warfighter today, tomorrow, and in the future
- The overarching objective of identifying those areas where targeted investment by the Naval S&T Enterprise will provide an order of magnitude increase in operational capability.

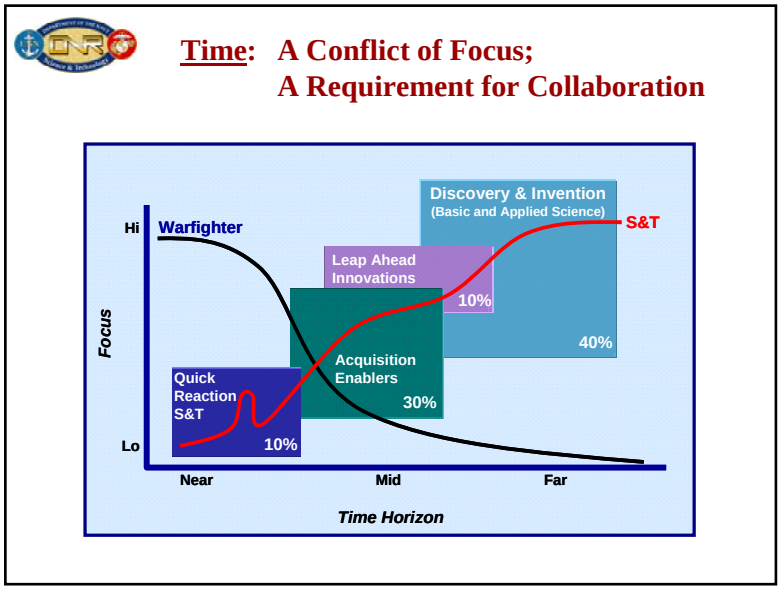

Figure 5: Conflicting Time Horizons Across the "3-Circles"

The participants then received three information briefs designed to set the stage for the remainder of the workshop. The first of these briefs is found in section C2 of Appendix C. This brief elaborated on the purpose and desired outputs of the workshop. The presenter challenged the participants to avoid recommendations for incremental improvements to current capabilities and invited them to continuously ask themselves the following question during the workshop: ***"What can we not do now that would make a huge operational difference if we could do so in the future?"***

The presenter used Figure 6 to describe the process that ONR 30 would use to transform the workshop outputs into its S&T investment strategy for DO.

To provide an awareness of other relevant DO-related events, the participants were then provided an overview of several recently completed DO-related studies, workshops, experiments, and war games that could serve as additional sources to inform the workshop's efforts and ONR 30's subsequent DO-related S&T investment planning process. This overview addressed the following completed events:

- USMC DO experimentation series (2005-2006)
- Naval Research Advisory Committee (NRAC) Summer Study (2005)

- NECC workshop (2006)
- DARPA DO architecture study (2006)
- Center for Emerging Threats & Opportunities (CETO): DO at the Strategic and Operational Level War Game (2006)
- ONR DO Logistics in Support of DO Workshop (2006)
- Sea Base Enablers Innovative Naval Prototype (INP) Workshop (2007)

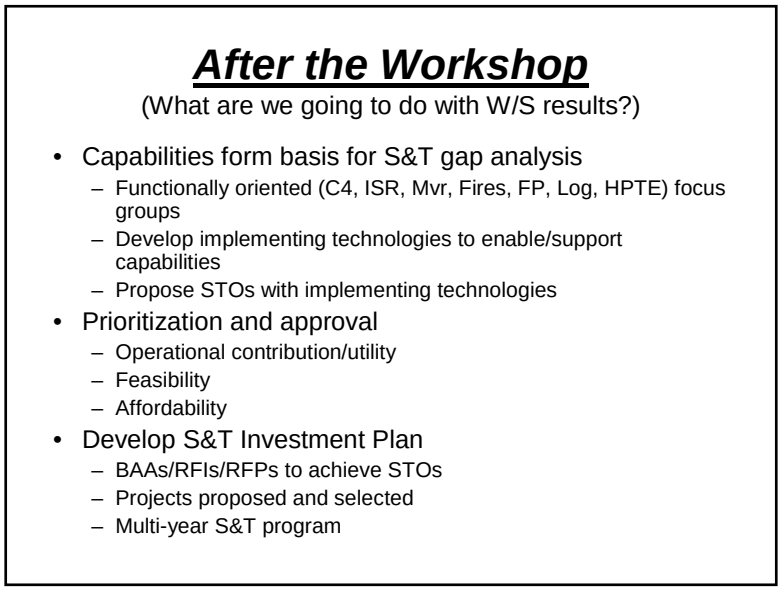

Figure 6: Plan for the Workshop's Outputs

The second information brief was a review of the scenario and CONOPS for the Naval campaign that would serve as the operational frame-of-reference for the workshop discussions. The workshop organizers had previously posted this information on the workshop website to facilitate its detailed preview by the participants. The details of this scenario and CONOPS are contained in Appendix D. This presentation elicited several questions from the audience which were answered by the presenter. This question and answer session is captured in Appendix E.

The workshop CONOPS time frame was the year 2020 and used the following assumptions to focus the working groups on identifying key capability gaps associated with the future conduct of Naval Distributed Operations.

- Marine Air Ground Task Forces (MAGTF) and NECC Expeditionary Echelons are capable of conducting DO.
- Capabilities currently being developed and/or fielded are operational. These capabilities include, but are not limited to, the MV-22 Osprey medium lift transport, CH-53K heavy lift helicopter, Joint Strike Fighter (JSF), Expeditionary Fighting Vehicle (EFV), Joint High Speed Vessel (JHSV), Maritime Pre-positioning Force (Future) (MPF(F)), Littoral Combat Ship (LCS), Mine Resistant Ambush Protected (MRAP) Vehicle, and replacements for current tactical truck and high mobility multipurpose wheeled vehicle fleets. In addition, Naval capabilities currently being developed and/or fielded under the Future Naval

Capability Pillars—Sea Shield, Sea Strike, Sea Base, and FORCENet—are operational.

- A Global Fleet Station (GFS) is operational in the US Pacific Command area of responsibility.
- Current command relationships are in effect.
- Current Naval task force organizations are employed:
  - A MAGTF includes a command, ground combat, air combat, and combat logistics elements. (MAGTFs in the CONOPS are Marine Expeditionary Units and Brigades.)
  - An NECC Expeditionary Echelon is tailored for the mission and includes Maritime Security, Construction/Engineering, Expeditionary Logistics Support, and Maritime Civil Affairs Task Groups.
  - An Expeditionary Strike Group includes an Amphibious Ready Group, MAGTF, and Surface Action Group.
  - A Carrier Strike Group includes a carrier, carrier air wing, and escorts consisting of surface combatants and attack submarines.

The final information brief presented a straw-man list of draft Naval DO operational tenets designed to focus the participants on a common understanding of the purpose of DO. These tenets are found in Figure 7. The participants were then introduced to a taxonomy of relevant terms and definitions that they were to use during the following working group discussions. This taxonomy is recreated in section C3 of Appendix C.

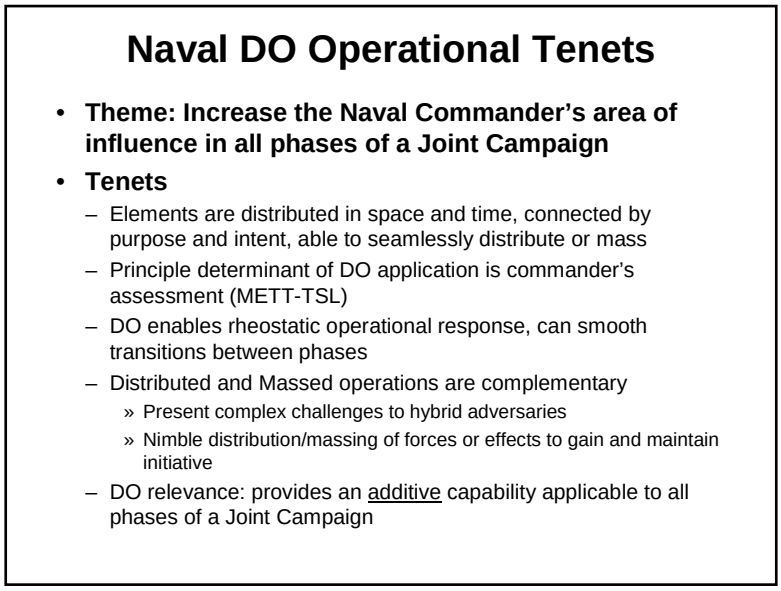

Figure 7: Draft Naval DO Operational Tenets

Working Group Sessions. Working Groups met on the afternoon of Day 1 and on the morning of Day 2 in order to discuss the challenges of DO and to identify key DO-related capability gaps with significant potential for S&T solutions. In addition to the scenario and Naval campaign

CONOPS, the following question was used to stimulate conversation and to refocus the groups' thought processes as required:

"What can we not do now, that if we could, would make significant operational difference?"

Additionally, each group was directed to develop a list of five to ten key capability gaps for presentation to the remainder of the workshop on the afternoon of Day 2. The workshop organizers placed this limit on the formal output from each working group to avoid the development of huge unprioritized "wish lists." The workshop organizers felt that these types of lists would do little to refine the DO challenge or to focus ONR 30's future S&T resource expenditures. Short, well-defined, well-articulated, and prioritized lists of key DO-related capability gaps were the ONR 30 objective. Each working group used a standardized template to collect and present the results of its deliberations.

Brief-outs and Workshop Conclusion. On the afternoon of Day 2, each working group briefed its results to the entire workshop and fielded related questions. The next section of this report presents these results. Col Dodge followed the brief-outs with a summary of the workshop, his concluding remarks, and a "thank you" for all involved.

Key Findings and Observations

This section presents the outputs provided by each individual working group and additional comments as appropriate.

Group A *(Phase 0 & 1)*. Group A used a group discussion methodology to identify thirteen key DO-related capability gaps. It then divided into smaller break-out groups to further define problem, articulate the capability gaps, and complete the standardized templates. The group then reformed, reviewed the templates, and selected its top seven key capability gaps. Group A's key capability gaps were as follows:

A1. Automatic rapid (real-time) capability to discriminate hostile from non-hostile behaviors in individuals or other entities, e.g., boats, vehicles

A2. Observe and quantify organizational / social activities and structures in order to anticipate potentially adverse behaviors

A3. Ability to effectively communicate via unclassified voice and/or data, timely information between DOD and non-DOD partners

A4. Need to support information management among DOD and non-DOD partners.

A5. Language and cultural fluency for every deploying unit to the small-unit level

A6. Capability to provide maneuver element with situational awareness

A7. Need for live-action interactive 3-D to support dynamic mission preparation, training, and rehearsal on-board ship

A significant portion of Group A's discussion centered on the challenge of interacting, coordinating, and collaborating with non-US military organizations operating within a common

area of interest (AOI). More fundamentally, US military forces are often unaware of the presence of other organizations within their areas of operations. This situation makes attempts at unified effort and/or optimal application of limit resources next to impossible.

While this specific aspect of situational awareness received a lot of Group A attention, the combination of four individually submitted capability gaps (A1, A2, A4, & A6) identified full-spectrum situational awareness as an overarching DO capability shortfall. Group A also identified the ability to "observe and quantify organizational/social activities and structures in order to anticipate potentially adverse behaviors" as a crucial form of *"situational forecasting."*

Group A's completed templates are available for review in section F1 of Appendix F.

Group B *(Phase 2 & 3)*. Group B's discussion was dominated by three driving considerations:

- A focus on small units conducting Distributed Operations
- Key DO employment challenges: *sustaining the unit, casualty care, & supporting the unit once decisively engaged*
- DO unit enhancements: *Decreased load/weight/size; increased survivability; increased lethality/effects*

During its general discussion, Group B identified seven key DO-related capability gaps and more than twenty additional gaps of lesser criticality. Its seven key capability gaps were as follows:

B1. Communications network organically linking DO units to higher headquarters network

B2. Extended small-unit senses and increased situational awareness within the AOI.

B3. Rapid generation of combat power ashore

B4. Increased logistical reach and reduced sustainment needs

B5. On-scene care to extend "golden hour" to enable casualty evacuation to distant medical facilities

B6. Small-unit conduct of electronic warfare (EW) activities within its sphere of influence

B7. Information operations tools

Additionally, Group B considered the use of DO as an operational method during phases 2 and 3 of a military campaign to be exceptionally risky—more so than during all other phases. Ultimately, however, the group agreed that the use of DO during any phase would be METT-TSL dependent.[6]

Group B's completed templates are available for review in section F2 of Appendix F.

[6] METT-TSL: Mission, Enemy, Terrain, Troops & Fires Support, Time, Space, Logistics; an acronym used during mission analysis and military risk assessment.

Group C *(Phase 4 & 5)*. Group C's discussion was dominated by three driving considerations:

- Communication and interaction with non-DoD actors *(NGOs, IOs, local forces, media, general populace)*
- DO implications for logistics, command and control, communications, and force protection
- Restriction of discussions to remain within the bounds of the straw-man draft Naval DO tenets *(except for the reaggregation of distributed units)*

During its general discussion, Group C identified eight key DO-related capability gaps and approximately forty subordinate gaps. The eight key capability gaps were as follows:

C1. Enable multi-level secure communications between NGOs, IOs, and U.S. military

C2. Establish real-time situational awareness throughout the area of responsibility (AOR)

C3. Acquire accurate real-time intelligence, synthesis of data, cultural understanding, predictive analysis

C4. Persistent sustainment of fuel, water, food and ammo persistently to distributed units from the Seabase

C5. Provide distributed training systems for DO units aboard ship and in theater

C6. Achieve secure infrastructure, persistent ISR, rapid response capability, and provide personnel protection

C7. Provision of medical care for casualties on demand over long distance on an individual basis

C8. Ability to perform combat mission at an enhanced physical level and maintain that level of performance for the duration of the mission.

Additionally, Group C articulated that an effective transition of military operations from phase 3 to phase 4 would require significant improvements in the military's ability to rapidly and effectively address the re-establishment of essential services and the handling of displaced persons. The group considered this issue to be an engineering challenge, but one that might be facilitated by future technologies as well.

Group C's completed templates are available for review in section F3 of Appendix F.

Analysis

The key capability gaps identified by the working groups are mapped to the Warfighting functions (plus HPT&E) in Table 1. Interestingly, 69% of the total number of gaps identified by the working groups map to only three of the seven functions: *Intelligence* (23%), *Logistics* (23%), and *Command & Control* (23%). Additionally, the working groups identified no top key

Maneuver capability gaps. The remainder of this section explores the details and issues behind these results and provides synthesis and consolidation as required to clarify and enhance the final workshop results.

	Group A	Group B	Group C
Command & Control	**A3, A4**	**B1**	**C1, C2**
Intelligence	**A1, A2, A6**	**B2**	**C3**
Fires	**A5**	**B6, B7**	
Maneuver			
Logistics		**B3, B4, B5**	**C4, C7**
Force Protection			**C6**
Human Performance, Training & Education	**A7**		**C5, C8**

TABLE 1: Capability Gaps Mapped to Warfighting Functions

Command and Control. The five *Command and Control* (C^2) gaps identified by the working groups divide into three logical sub-groups.

☐ ***Communicate and share information with distributed small-units located beyond line-of-sight, on the move, and within complex terrain in order to assure real-time access to required levels of functional support*** (B1). This key capability gap corresponds to one of the three "show stoppers" identified in the 2005 NRAC Summer Study and constitutes a major risk factor in the ability to execute DO at the lowest tactical levels.[7] Critical shortcomings of current systems include: size, weight and power (SWAP) issues; bandwidth limitations; line-of-sight and complex terrain limitations, and the inability to maintain reliable communications while on the move.

☐ ***Maintain an adaptable, self-forming (aggregating/disaggregating), and self-regulating (bandwidth control) C^2 system in order to maintain an autonomous multi-echelon COP and facilitate synchronization of effort across the area of operations*** (C2). This key capability gap focuses on the automation and enhancement of traditional blue force C^2

[7] The 2005 NRAC Summer Study final brief is located at:
http://www.onr.navy.mil/nrac/docs/2006_brief_distributed_operations.pdf

and COP capabilities. Key challenges include: dynamic scalability, bandwidth control, robust communications networks, and information management. Dynamic scalability refers to the system's requirement to expand and contract to support the C^2 requirements of a DO force as is disaggregates and aggregates in response to the military situation.

☐ ***Communicate (voice & data) and collaborate (information management and data sharing) with all relevant organizations inside a distributed force's area of interest in order to facilitate unity of purpose and optimize the use of critical resources*** (A3, A4, & C1). This key capability gap addresses the Warfighter's inability to communicate and remotely collaborate with non-governmental organizations (NGO), international organizations (IO), and host nation (HN) agencies within his AOR/AOI. This capability gap also addresses the inability to share data across secure and non-secure networks. Unsurprisingly, this gap was deemed especially critical by Groups A and C. Effective communication, coordination, and collaboration between military and non-military entities are a fundamental requirement for effective Phase 0, 1, 4 & 5 operations. Key challenges in this area include: the existence of multiple incompatible communications and common operational picture (COP) maintenance systems within a typical AOI; automated translation and interpretation; cumbersome information management and classification processes; and extensive policy, doctrine, organization, and training issues.

Intelligence. The five *Intelligence* gaps identified by the working groups also divide into three logical sub-groups.[8] A common theme across all three sub-groups was the necessity to achieve automated real-time situational awareness across multiple domains (physical, virtual, and human) in order to achieve anticipatory understanding.[9]

☐ ***Achieve and maintain real-time automatic situational awareness of relevant non-blue activities at all echelons in order to mitigate the increased operational risk to small-units engaged in Distributed Operations*** (A6 & B2) This key capability gap focuses on the distributed unit's ability to establish a "bubble of awareness" that is responsive to its unique and adapting needs and that is complete enough to enable a timely response to relevant threat activities. Key issues in this area include the trade space between increased organic ISR assets and increased small-unit access to higher level ISR assets/products, real time threat data fusion and automated dissemination to the appropriate user, supporting communications networks, user interfaces, effective alert mechanism, and decision support tools.

☐ ***Conduct real-time automatic detection, tagging, tracking, and locating of known and potential threats in order to eliminate the irregular threat's freedom of movement***

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[8] It is interesting to note that the 2005 NRAC Summer Study did not identify ISR or situational awareness as potential DO "show stoppers" nor were they listed as recommended S&T investment topics.

[9] The Joint Capability Areas Lexicon (Post 24 dtd August 2006) defines the relevant domains for battlespace awareness as: Physical -- maritime, air, space, land; Virtual -- cyber and information; and Human -- social, moral and cognitive). Anticipatory understanding means that the commander has sufficient knowledge of the environment which, when coupled with his intuition and judgment, allows him to determine, with a high degree of confidence, required actions in advance of situational developments including enemy opposing actions. (From Major Combat Operations Joint Operating Concept, version 2.0 dtd Dec 06, p35)

(A1) This key capability gap addresses the ability of irregular forces to "hide in plain sight." Currently, both known and potential threat entities can roam the irregular battlespace until they become active at a time and place of their choosing. Future technologies must allow the Warfighter to eliminate this threat "anonymity" and must support the interdiction and isolation of threat activities within all domains. Key challenges associated with this goal will include: collection and detection of biometric data in tactical relevant situations, relevant anomaly detection, pattern recognition, deception detection, autonomous track acquisition and maintenance, and information management.

☐ ***Collect relevant social data and fuse it to facilitate assessments and predictions for operational benefit in order to dominate the human domain of warfare*** (A2 & C3) This key capability gap addresses the challenge of understanding and navigating the human terrain within a foreign culture. Such an understanding is crucial to influencing and manipulating the center of gravity in irregular warfare (IW)—the relevant population.[10] "IW is a complex, 'messy,' and ambiguous social phenomenon."[11] While technology may not be the panacea for dominating this phenomenon, it must be adapted to enable and enhance the human dimension of irregular warfare. The fundamental challenge for this area may well be the determination of exactly what data needs to be collected—which activities and anomalies are relevant and which are simple more noise in an exceptionally low signal-to-noise ratio (SNR) environment? Key objectives should include the development of anticipatory understanding aids for local social interactions; tools for developing culturally astute courses of action; tools for modeling and simulating local social networks; and tools for assessing potential 2nd and 3rd order effects of friendly, neutral, and threat activities on the perceptions of the relevant population.

Logistics. Again, the five *Logistics* gaps identified by the working groups divide into three logical sub-groups.

☐ ***Automatically sense, package, and rapidly deliver tailored logistics packages from the Seabase to distant small-units operating on a distributed battlefield in order to enable Distributed Operations*** (B3, B4 & C4) This key capability gap corresponds to one of the three "show stoppers" identified in the 2005 NRAC Summer Study and constitutes a major risk factor in the ability to execute DO at the lowest tactical levels. This logistics-oriented capability gap has three primary components:

- Total Asset Visibility – This component is concerned with near real-time (NRT) access to the data and information necessary to anticipate/predict supply requirements and component failures down to the squad level. This focused knowledge must be developed and disseminated with enough lead-time to facilitate the success of the remaining two components.
- Automated Selective Offload and Precision Packaging – Seabase platforms must possess the warehousing and material handling capabilities necessary to enable the rapid building of logistics packages tailored to the specific and immediate requirements of

[10] The Irregular Warfare Joint Operating Concept ver 1.0 dtd Feb 07 defines Irregular Warfare as: "A violent struggle among state and non-state actors for legitimacy and influence over the relevant populations."
[11] Irregular Warfare Joint Operating Concept ver 1.0 dtd Feb 07, p4.

distributed units down to the squad level. The physical characteristics of these packages must then support their rapid delivery to the end-user.

- Autonomous Precision Delivery – An autonomous delivery system must then connect the Seabase with the distributed force. It must be capable of continuously delivering daily sustainment packages to distributed units as small as squads. It must also be capable of delivering tailored resupply packages to small-units in contact with the enemy. The development of autonomous, long-range, high-speed "connectors" may prove to be the method of addressing this capability gap.

☐ ***Reduce sustainment demand of distributed small-units in order to decrease stress to the Seabased logistics system*** (B4 & C4) This key capability gap addresses the ability of distributed forces to "live off the land" and to increase the efficiencies of their warfighting systems. Leveraging local resources and reducing consumption rates will reduce the stress on any logistics system and will benefit any future warfighting methodology. Key issues associated with this goal will include: battery power density limitations, reduced vehicle fuel consumption, novel power generation, water generation, and alternative fuels.

☐ ***Conduct advanced casualty stabilization & long-range evacuation at the small-unit level in order to mitigate the increased operational risk to small-units engaged in Distributed Operations*** (B5 & C8) This key capability gap focuses on a critical DO risk mitigation measure that is routinely highlighted by operational commanders. While enhanced field stabilization capabilities are critical for DO risk mitigation, probably more problematic is the challenge of long-range casualty evacuation (CASEVAC). This capability gap is the operational complement to the *autonomous precision delivery* logistics capability gap discussed above. The ability to deliver high value packages into the distributed squad's AOR is just one half of the problem. Extracting injured Warfighters from the AOR and keeping them stable during transit is the other half. While not specifically spelled out in the 2005 NRAC Summer Study, one may infer this gap from the NRAC study's general treatment of the CASEVAC issue and by its list of S&T specific recommendations. The NRAC study also highlighted the potential challenge of providing casualties with critical medical treatment during the "Golden Hour."[12] Figure 8 provides a summary of NRAC's DO "show stoppers" and its S&T recommendations.

Human Performance, Training, and Education. The 2005 NRAC Summer Study identified *Education and Training* as one of the three potential "show-stoppers" for DO implementation. It also discussed the need for enhancing Warfighter cognitive and physiological enhancements, as well as the possible need to "age the force."

☐ ***Rapidly enhance Warfighter cognitive processes and experiential baselines in order to prepare leaders at all echelons for Distributed Operations*** (A7, C5 & C8) DO will require small-unit leaders to rapidly assess unfamiliar situations and make potentially strategic decisions on a much more frequent basis than currently experienced. Furthermore,

[12] The "Golden Hour" refers to the commonly accepted belief that survival rates fall dramatically when elapsed time between traumatic injury and definitive medical treatment exceeds 60 minutes. While current studies may contradict the accuracy/precision of this assertion, one cannot argue with the idea that traumatic injury victims have a better chance of survival when they receive professional medical treatment as rapidly as possible.

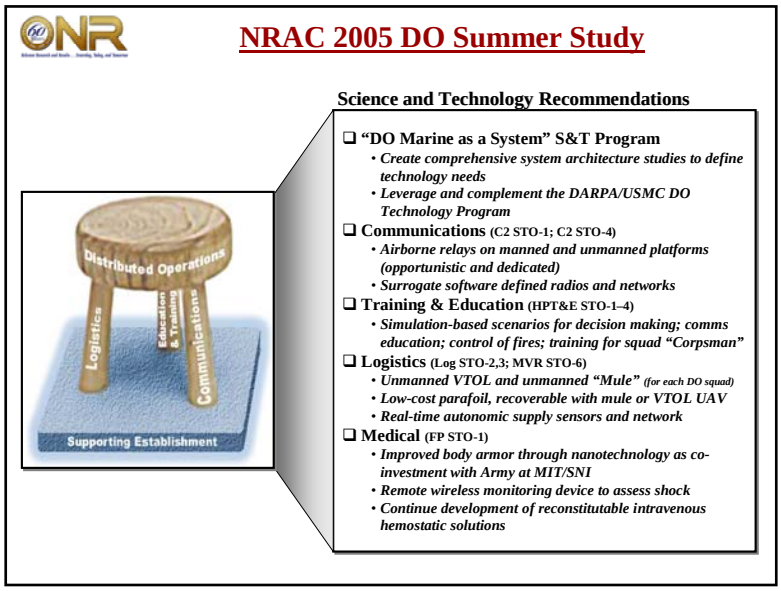

Figure 8: NRAC DO S&T Recommendations

these decisions must be adaptive—especially when engaged in irregular warfare. The right "decision" today may not be the "right" decision tomorrow. This capability gap addresses the ability to screen for desired cognitive competencies, enhance these competencies, and compress the time required to gain the "experience" necessary to operationalize these competencies.

❑ ***Enhance Warfighter physiological/psychological performance in order to mitigate the increased risks of Distributed Operations*** (C7) This key capability gap focuses on the ability to enhance the Warfighter's ability to perform over extended periods of physiological and psychological stress. These stresses may include sleep deprivation, physical exertion, and poor nutrition/hydration. Group C discussed the use of performance enhancing pharmaceuticals as well as the associated ethical and policy implications. The group also considered the use of exoskeleton technologies as well as "lighten the load" concepts during its discussions.

❑ ***Rapidly acquire the operational culture and language skills in order to dominate the virtual and human domains of warfare*** (C5) This key capability gap addresses the force multiplication provided by an operational expertise in navigating the human/social terrain within one's AOR. The expeditionary nature of Naval Warfighters will require them to rapidly assimilate and exploit operationally relevant knowledge about unfamiliar cultures and societies on a relatively routine basis. This capability will be a critical factor during the early and late phases of the joint campaign cycle and in the continuous "battle of influence" which is the key to IW. Key challenges associated with this goal will include: adaptive/learning translation and interpretation aids, reach-back capabilities, culturally attuned course-of-action analysis, 2nd and 3rd order effect determination, and the basic determination of what cultural issues are operationally relevant.

❑ ***Conduct dynamic mission preparation, training, and rehearsal while deployed aboard ship or in theater in order to enhance operational performance and minimize unintended consequences*** (A7 & C5) This key capability gap addresses a DO forces ability to

conduct realistic, relevant, and value-added mission planning, training and rehearsal activities when time and space are limited. Technologies addressing this capability must be scalable, "user-editable," and culturally adaptable.[13] They must also address the physical, virtual, and human domains of warfare.

Fires and Force Protection

□ ***Conduct selected core Information Operations activities at the small-unit level in order to dominate the influence battle*** (A5, B6 & B7)[14] While each working group discussed the topic of *Fires* during its working session, none of them identified enhanced traditional kinetic fires (or increase functional access to existing *Fires*) as a key DO capability gap. Two of the groups, however, did identify the conduct of a subset of core Information Operations (IO) activities at the small-unit level as a key capability gap.[15] This subset included limited electronic warfare (EW), psychological operations (PSYOP), and operational security (OPSEC). The purpose of this subset was to enable the distributed small-unit to exert an increase level of influence across its AOR. One can consider IO and/or "influence operations" as the *Fires* of Irregular Warfare.

□ ***Protect critical infrastructure in order to maintain essential services and bolster the legitimacy of the supported civil authority*** (C6) This key capability gap addresses the challenge of protecting a large target set over an extensive and complex physical area with minimal resources when the threat can choose the time/place/method of engagement and possesses a substantial degree of freedom of movement. This was the only Force Protection oriented key capability gap identified by the working groups.

As previously mentioned, no specific *Maneuver*-related key capability gaps were submitted by the working groups as priority shortfalls. All working groups, however, did discuss *Maneuver* capability gaps during their deliberations. One can attribute the absence of a specific key *Maneuver* capability gap to the workshop's design. One of the assumptions used for the CONOPS was that the capabilities scheduled to be in the Operating Forces by the year 2020 would, in fact, be available. This assumption provided the notional Naval force with several enhanced mobility capabilities. MV-22s, CH-53K, EFV, MRAP, and replacements for the current tactical truck and HMMWV fleets provided significant improvements to current tactical mobility capabilities. Additionally, MPF(F), JHSV, and Sea Base capabilities offered considerable contributions to the rapid build-up of combat power ashore. Based on these enhanced mobility capabilities, the three working groups felt that the current programs of record

[13] "User-editable" refers to the ability of the Warfighter, at any echelon and with minimal training, to rapidly adapt the virtual training scenario to address a particular unique event or mission. Systems requiring large support systems will not address this capability gap.

[14] While the title of A5 might initially place it in the HPT&E category, a close review of the capability template reveals that it is actually concerned with access to the information and expertise required to conduct immediate tactical Information (or Influence) Operations—IW *Fires*.

[15] At first glance, Gap A5 might appear to be an HPT&E gap. The potential enhancements cited, however, are singularly focused on gaining rapid access to cultural knowledge and incite required to exert influence on a target audience. They are not concerned with training or enhancing the cognitive capabilities of the Naval Warfighter.

provided adequate tactical and operational level maneuver capabilities for Naval DO in the context of the CONOPS under consideration. This assumption led the working groups to focus on other critical functional areas. Furthermore, the workshop facilitators asked the participants to identify key capability gaps from an S&T perspective. In other words, they were asked to identify the capability gaps that could not be resolved by purchasing larger quantities of programmed capabilities. They were asked to identify capability gaps whose material solutions had not yet been invented.

Conclusion

The overarching objective of the ***S&T in Support of Naval Distributed Operations Workshop #2*** was to identify those areas where targeted investment by the Naval S&T Enterprise would provide an order of magnitude increase in operational capability. The participants included both experienced operators and technologist. They focused their efforts towards this overarching objective by asking, **"What can we not do now, that if we could, would make significant operational difference?"** The resulting seminar analysis and synthesis of this question are documented above and clearly indicate the objective was achieved. The results are further summarized in the below synthesized DO-related key capability gaps:

1. Communicate and share information with distributed small-units located beyond line-of-sight, on the move, and within complex terrain in order to assure real-time access to required levels of functional support
2. Maintain an adaptable, self-forming (aggregating/disaggregating), and self-regulating (bandwidth control) C^2 system in order to maintain an autonomous multi-echelon COP and facilitate synchronization of effort across the area of operations
3. Communicate (voice & data) and collaborate (information management and data sharing) with all relevant organizations within a distributed force's areas of interest in order to facilitate unity of purpose and optimize the use of critical resources
4. Achieve and maintain real-time automatic situational awareness of relevant non-blue activities at all echelons in order to mitigate the increased operational risk to small-units engaged in Distributed Operations
5. Conduct real-time automatic detection, tagging, tracking, and locating of known and potential threats in order to eliminate the irregular threat's freedom of movement
6. Collect relevant social data and fuse it to facilitate assessments and predictions for operational benefit in order to dominate the human domain of warfare
7. Automatically sense, package, and rapidly deliver tailored logistics packages from the Seabase to distant small-units operating on a distributed battlefield in order to enable Distributed Operations
8. Reduce sustainment demand of distributed small-units in order to decrease stress to the Seabased logistics system

9. Conduct advanced casualty stabilization & long-range evacuation at the small-unit level in order to mitigate the increased operational risk to small-units engaged in Distributed Operations
10. Rapidly enhance Warfighter cognitive processes and experiential baselines in order to prepare leaders at echelons for Distributed Operations
11. Enhance Warfighter physiological/psychological performance in order to mitigate the increased risks of Distributed Operations
12. Rapidly acquire the operational culture and language skills in order to dominate the virtual and human domains of warfare
13. Conduct dynamic mission preparation, training, and rehearsal while deployed aboard ship or in theater in order to enhance operational performance and minimize unintended consequences
14. Conduct selected core Information Operations activities at the small-unit level in order to dominate the influence battle
15. Protect critical infrastructure in order to maintain essential services and bolster the legitimacy of the supported civil authority

During the writing of this report, DO advocates at the Marine Corps Combat Development Command (MCCDC) informed ONR 30 that it would complete its formal DO concept and capability development process during June 2007. ONR 30 will provide this document to the participants in this development process in order to inform and facilitate the identification of long-term capability gaps requiring the focused expenditure of Technology Developer resources. ONR 30 also expects this report to inform the ongoing revision of the Marine Corps S&T Strategic Plan and the development of the NECE S&T Strategic Plan. Each of these activities will reach their conclusions during the upcoming Summer. Once completed, the outputs of these activities will provide the final input into ONR 30's S&T investment strategy for DO and will energize its continuing advocacy of the S&T needs of the future Naval Warfighter.

APPENDICES

Appendices A-F are FOR OFFICIAL USE ONLY.

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Expeditionary Maneuver Warfare & Combating Terrorism S&T Department

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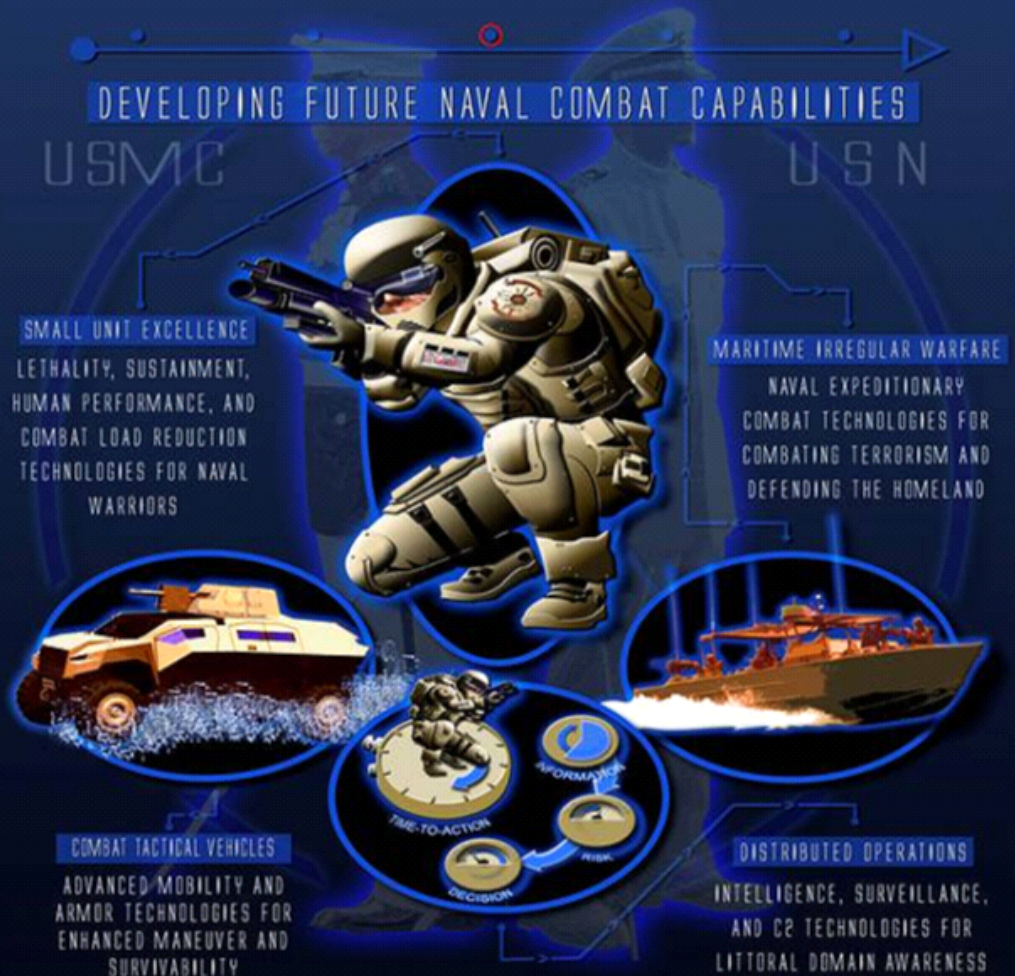

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